Fig. 1

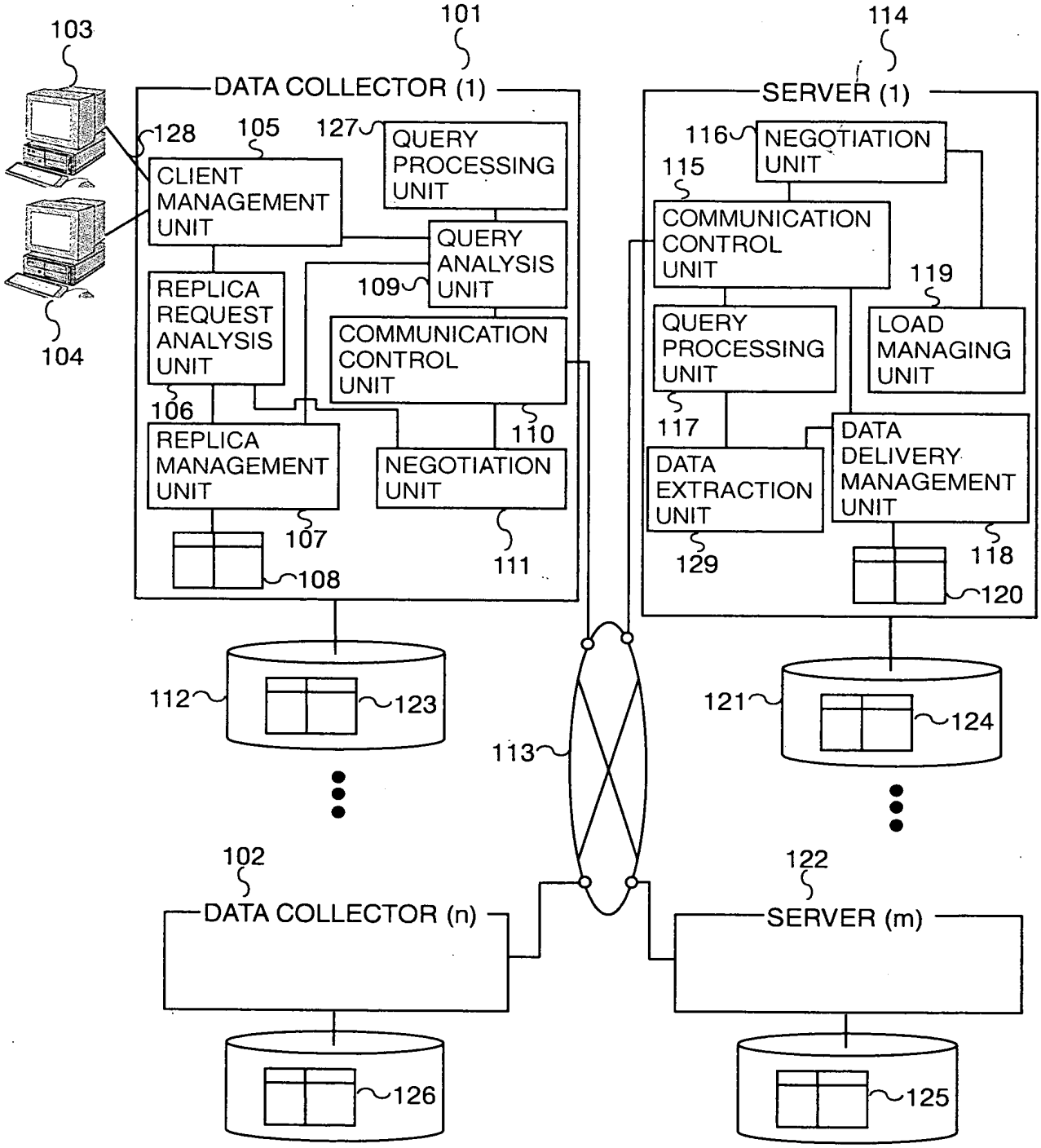

103
101
114
DATA COLLECTOR (1)
SERVER (1)
128
105
127
QUERY PROCESSING UNIT
116
NEGOTIATION UNIT
115
CLIENT MANAGEMENT UNIT
COMMUNICATION CONTROL UNIT
QUERY ANALYSIS UNIT
109
119
REPLICA REQUEST ANALYSIS UNIT
QUERY PROCESSING UNIT
LOAD MANAGING UNIT
104
COMMUNICATION CONTROL UNIT
106
117
110
REPLICA MANAGEMENT UNIT
NEGOTIATION UNIT
DATA EXTRACTION UNIT
DATA DELIVERY MANAGEMENT UNIT
107
118
129
108
111
120
112
123
121
124
113
102
122
DATA COLLECTOR (n)
SERVER (m)
126
125

Fig. 2

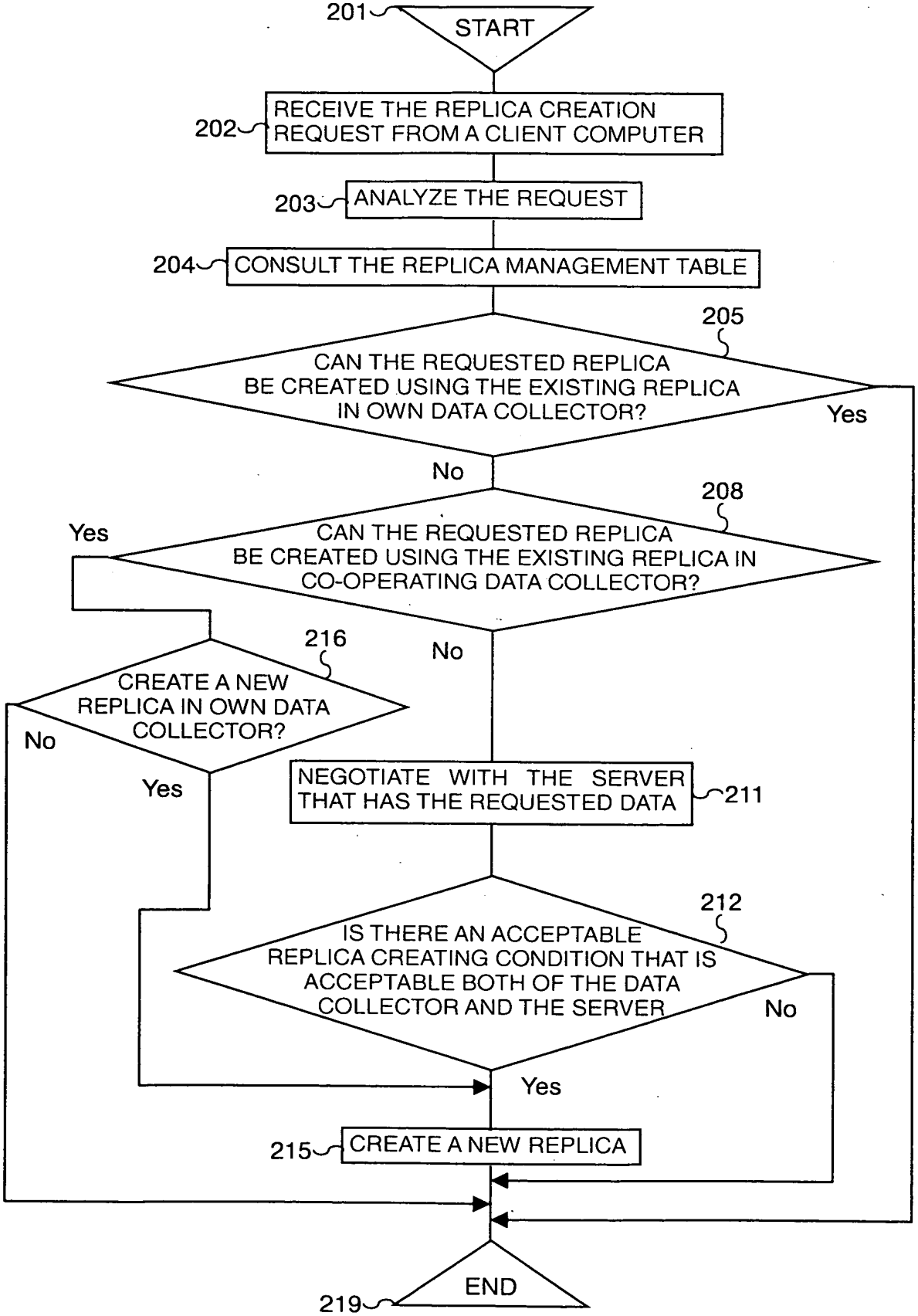

201
START
202
RECEIVE THE REPLICA CREATION REQUEST FROM A CLIENT COMPUTER
203
ANALYZE THE REQUEST
204
CONSULT THE REPLICA MANAGEMENT TABLE
205
CAN THE REQUESTED REPLICA BE CREATED USING THE EXISTING REPLICA IN OWN DATA COLLECTOR?
Yes
No
208
CAN THE REQUESTED REPLICA BE CREATED USING THE EXISTING REPLICA IN CO-OPERATING DATA COLLECTOR?
Yes
No
216
CREATE A NEW REPLICA IN OWN DATA COLLECTOR?
No
Yes
NEGOTIATE WITH THE SERVER THAT HAS THE REQUESTED DATA
211
212
IS THERE AN ACCEPTABLE REPLICA CREATING CONDITION THAT IS ACCEPTABLE BOTH OF THE DATA COLLECTOR AND THE SERVER
No
Yes
215
CREATE A NEW REPLICA
219
END

Fig. 3

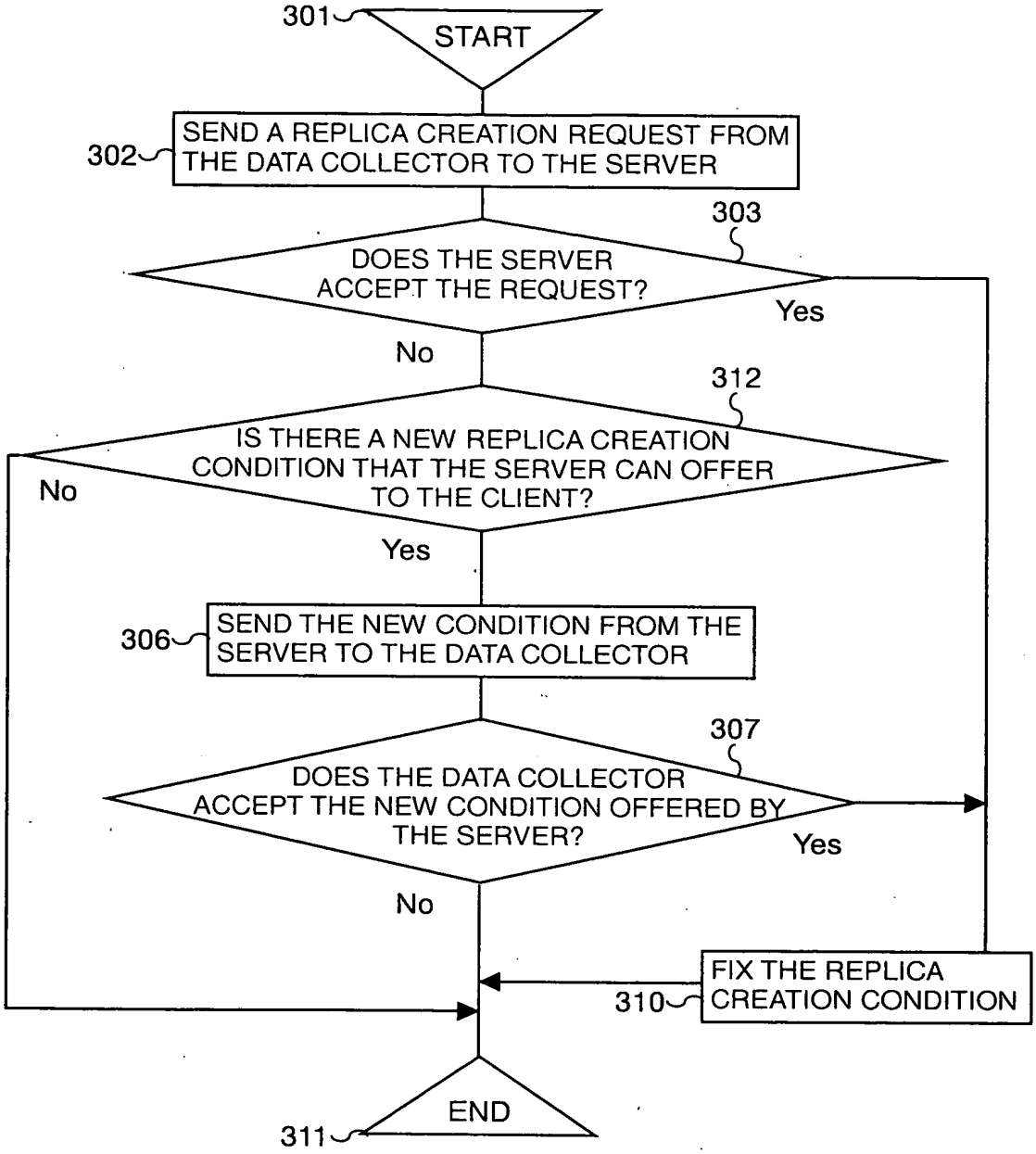

301
START
302
SEND A REPLICA CREATION REQUEST FROM THE DATA COLLECTOR TO THE SERVER
303
DOES THE SERVER ACCEPT THE REQUEST?
Yes
No
312
IS THERE A NEW REPLICA CREATION CONDITION THAT THE SERVER CAN OFFER TO THE CLIENT?
No
Yes
306
SEND THE NEW CONDITION FROM THE SERVER TO THE DATA COLLECTOR
307
DOES THE DATA COLLECTOR ACCEPT THE NEW CONDITION OFFERED BY THE SERVER?
Yes
No
310
FIX THE REPLICA CREATION CONDITION
311
END

Fig. 4

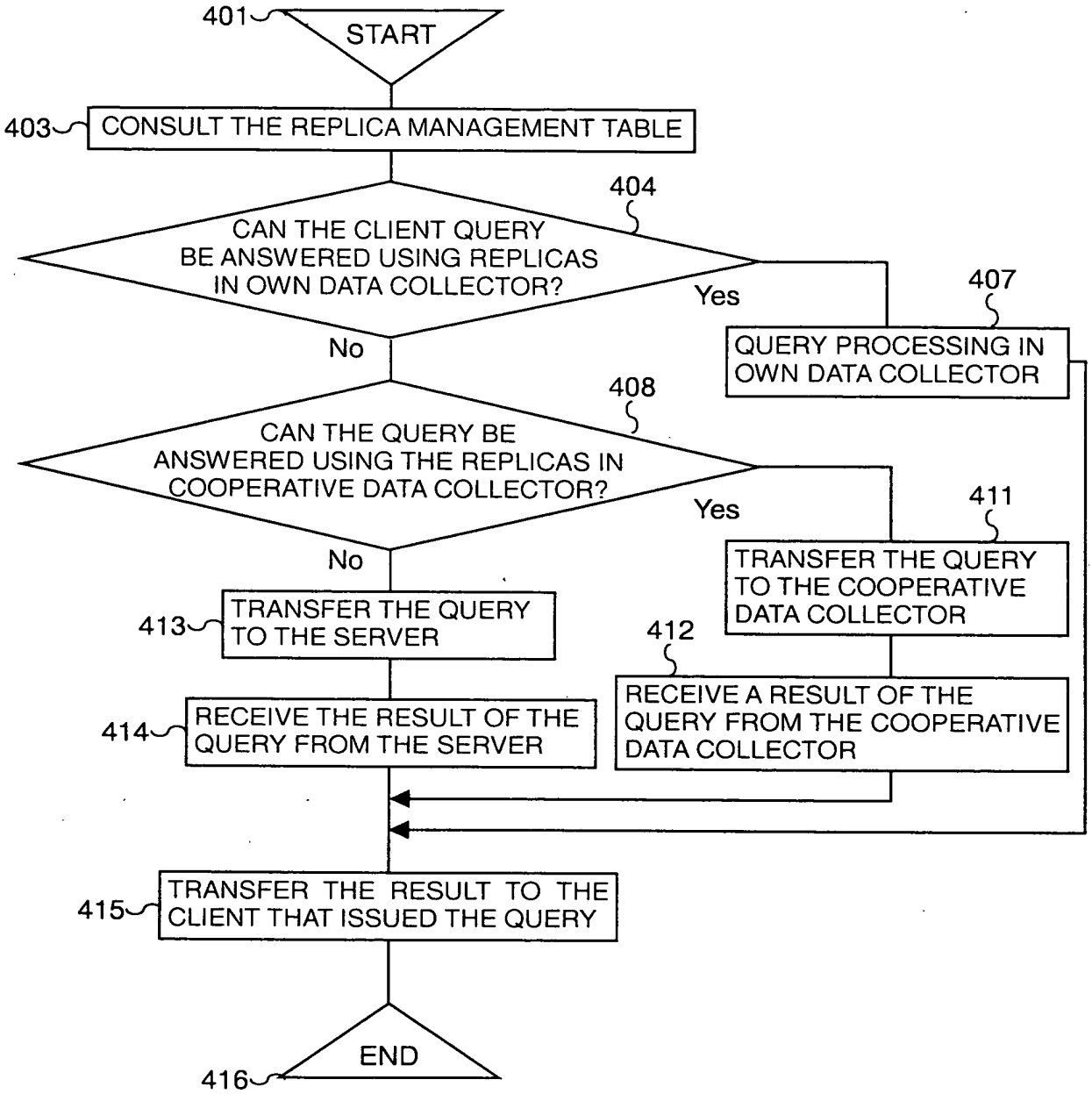

401
START
403
CONSULT THE REPLICA MANAGEMENT TABLE
404
CAN THE CLIENT QUERY BE ANSWERED USING REPLICAS IN OWN DATA COLLECTOR?
Yes
No
407
QUERY PROCESSING IN OWN DATA COLLECTOR
408
CAN THE QUERY BE ANSWERED USING THE REPLICAS IN COOPERATIVE DATA COLLECTOR?
Yes
No
411
TRANSFER THE QUERY TO THE COOPERATIVE DATA COLLECTOR
412
RECEIVE A RESULT OF THE QUERY FROM THE COOPERATIVE DATA COLLECTOR
413
TRANSFER THE QUERY TO THE SERVER
414
RECEIVE THE RESULT OF THE QUERY FROM THE SERVER
415
TRANSFER THE RESULT TO THE CLIENT THAT ISSUED THE QUERY
416
END

Fig. 5

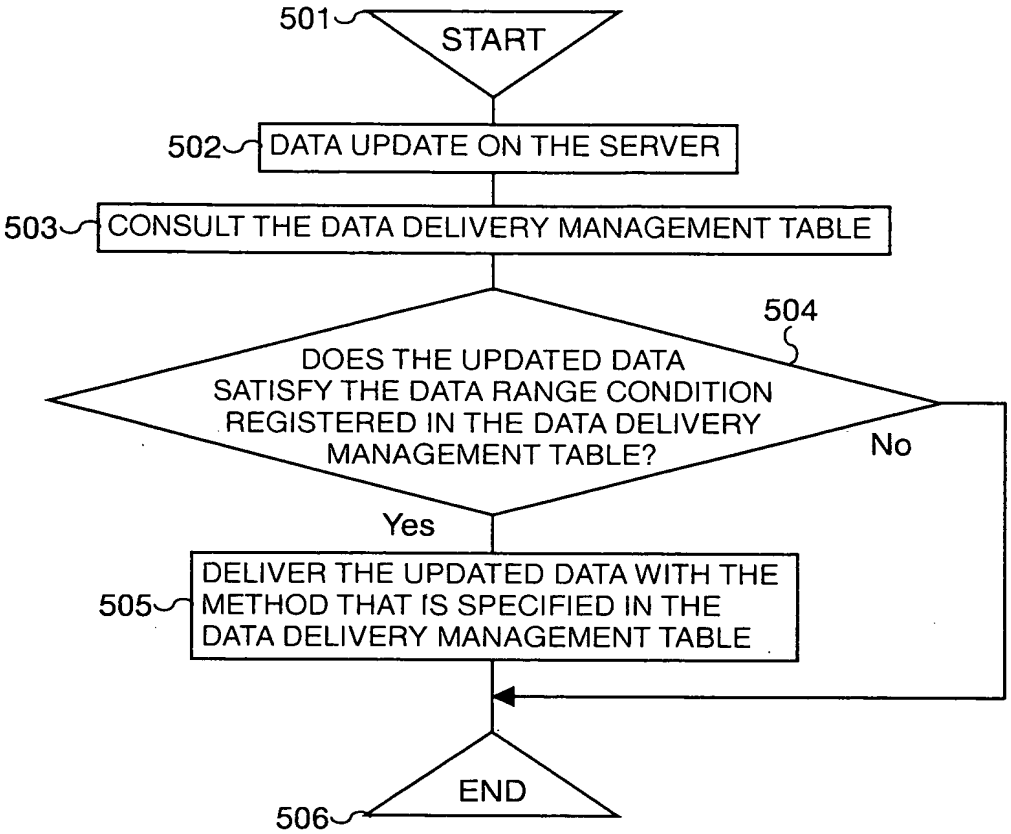


Fig. 6

REPLICA CREATION REQUEST

601 DATA RANGE	603 DATA QUALITY	604 DELIVERY METHOD
ORDER(ORDER_ID, PRICE, CUSTOMER_ID) PRICE>=10000	-	13:00, PUSH
ORDER(ORDER_ID, PRICE, CUSTOMER_ID), 5000<=PRICE<=8000	FRESH(ORDER, 1 HOUR) 605	{1:00, 13:00}, PULL
ORDER(ORDER_ID, PRICE, CUSTOMER_ID), PRICE<=2000	SAMPLE(ORDER, ORDER_ID, 10%) 606	ONCE BETWEEN 21:00 AND 23:00, PULL
SALESDETAIL(ORDER_ID, SHIPDATE, ORDER_AMOUNT), SHIPDATE>=1990/01/01	TOP-N(SALESDATAIL, ORDER_AMOUNT, 100) 607	ONCE PER 1 HOUR, PULL
...	...	...

Fig. 7

DATA TYPE	DATA QUALITY ADJUSTMENT METHOD
RELATIONAL DATABASE RECORD	RECORD SAMPLING, COLUMN PROJECTION
DOCUMENT	KEYWORD EXTRACTION, SUMMARY CREATION
IMAGE	IMAGE COMPRESSION, IMAGE FORMAT CONVERSION, EXTRACT OUTLINE, REDUCE THE NUMBER OF COLORS, REDUCE RESOLUTION, MAKE IMAGE SIZE SMALLER
MOVIE	REDUCE FRAME RATE, IMAGE COMPRESSION IN A FRAME
SOUND	CHANGE SAMPLING RATE, CONVERT TO CHARACTER INFORMATION

Fig. 8

REPLICA MANAGEMENT

REPLICA DESCRIPTION		REPLICA LOCATION (803)	SERVER LOCATION (804)	DELIVERY METHOD (805)
DATA RANGE (801)	DATA QUALITY (802)			
ORDER(ORDER_ID, PRICE, CUSTOMER_ID), PRICE>=10000	-	DATA COLLECTOR (1)	SERVER (1)	13:00, PUSH (806)
ORDER(ORDER_ID, PRICE, CUSTOMER_ID), PRICE>=10000	- (807, 808)	DATA COLLECTOR (3)	SERVER (1)	{1:00, 13:00}, PULL
ORDER(ORDER_ID, PRICE), PRICE<=3000	-	DATA COLLECTOR (2)	SERVER (2)	12:00, PUSH
ORDER(ORDER_ID, PRICE), 3000<=PRICE<=5000	SAMPLE(ORDER, ORDER_ID, 10%)	DATA COLLECTOR (2)	SERVER (2)	ONCE PER 2 HOURS, PULL

Fig. 9

DELIVERY DATA MANAGEMENT TABLE

901 DATA RANGE	902 DATA QUALITY	903 DELIVERY DESTINATION	904 DELIVERY METHOD	
ORDER(ORDER_ID, PRICE, CUSTOMER_ID), PRICE>=10000	-	DATA COLLECTOR (1)	13:00, PUSH	905
ORDER(ORDER_ID, PRICE, CUSTOMER_ID), PRICE>=10000	-	DATA COLLECTOR (3)	{1:00, 13:00}, PUSH	906
ORDER(ORDER_ID, PRICE, CUSTOMER_ID), PRICE>=50000	TOP-N(ORDER, PRICE, 10)	DATA COLLECTOR (7)	ONCE PER 1 HOUR , PULL	
...	...		...	

INSERT DATA

(ORDER_ID, PRICE, CUSTOMER_ID) = (10005, 12500, 256) 907

Fig. 10

(A) DELIVERY CREATION REQUEST

DATA RANGE	DATA QUALITY	DELIVERY METHOD	
ORDER(ORDER_ID, PRICE, CUSTOMER_ID) PRICE>=10000	-	13:00, PUSH	1001
ORDER(ORDER_ID, PRICE, CUSTOMER_ID), 5000<=PRICE<=8000	FRESH(ORDER, 1 HOUR)	{1:00, 13:00}, PUSH	
SALESDETAIL(ORDER_ID, SHIPDATE, ORDER_AMOUNT), SHIPDATE>=1990/01/01	-	ONCE PER 1 HOUR, PULL	1002
...	...	...	

(B) SERVER REPLY

SERVER REPLY	DATA RANGE	DATA QUALITY	DELIVERY METHOD	
ACCEPT	-	-	13:00, PUSH	1003
ACCEPT	-	-	{1:00, 13:00}, PUSH	
CONDITIONALLY ACCEPT	SALESDETAIL(ORDER_ID, SHIPDATE, ORDER_AMOUNT), SHIPDATE>=1994/01/01	-	ONCE PER 2 HOURS , PULL	1004
...	...	...	...	

Fig. 11

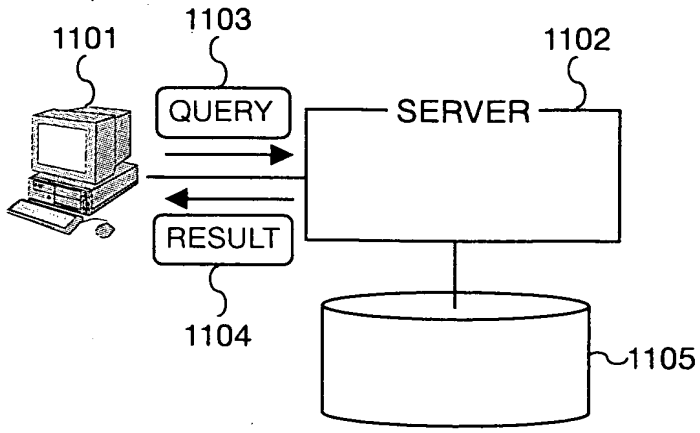

1101
1103
1102
QUERY
SERVER
RESULT
1104
1105

Fig. 12

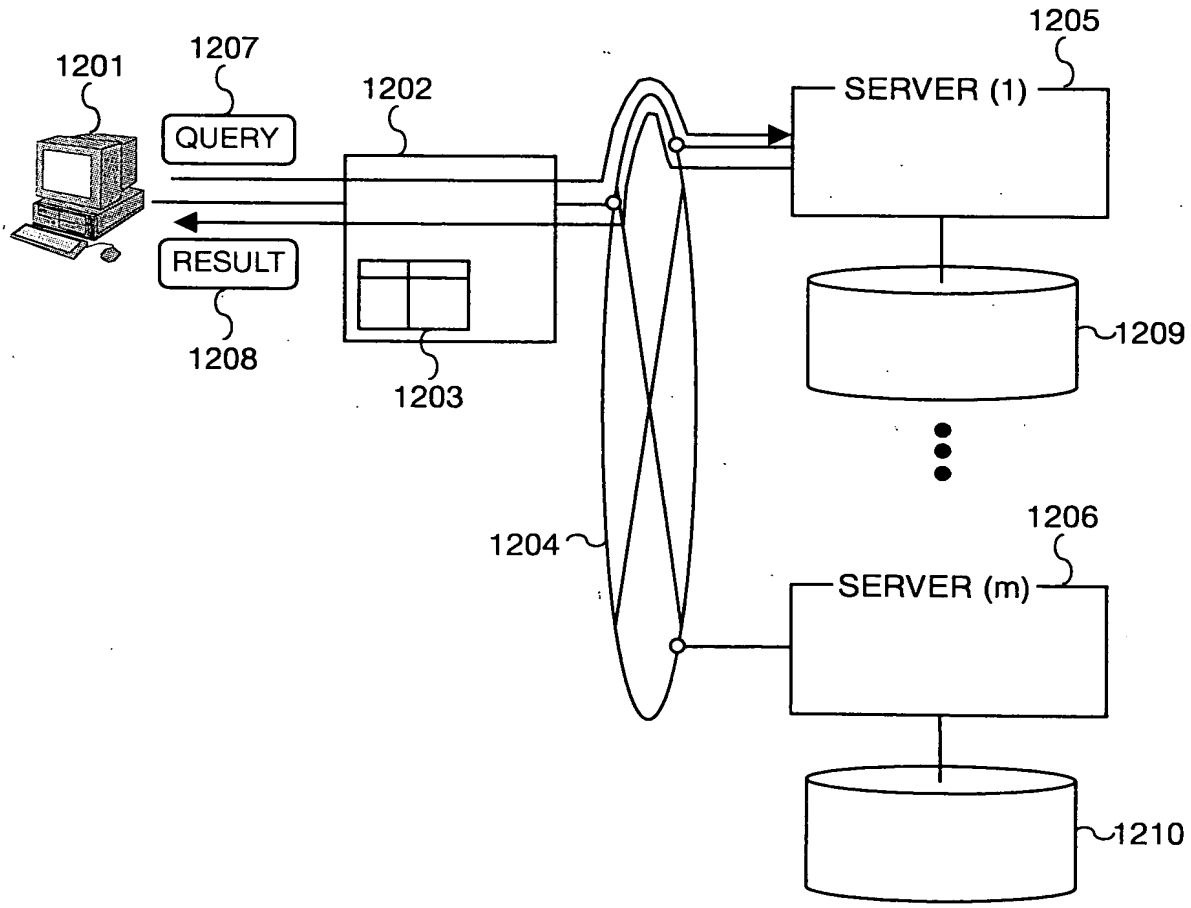

1201
1207
1202
1205
QUERY
SERVER (1)
RESULT
1208
1203
1209
1204
1206
SERVER (m)
1210

Fig. 13

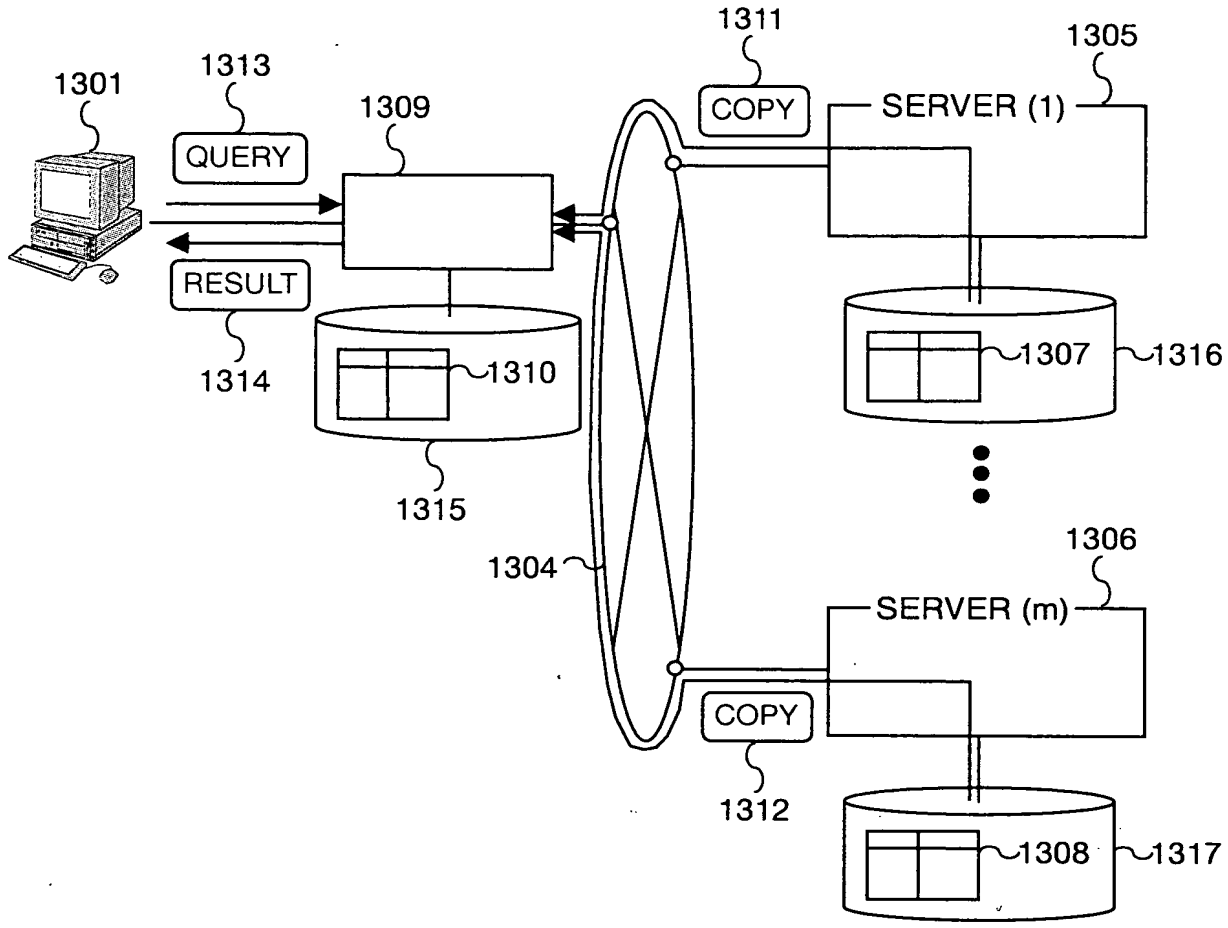

1301
1313
QUERY
RESULT
1314
1309
1310
1315
1311
COPY
1305
SERVER (1)
1307
1316
1304
1306
SERVER (m)
COPY
1312
1308
1317

Fig. 14

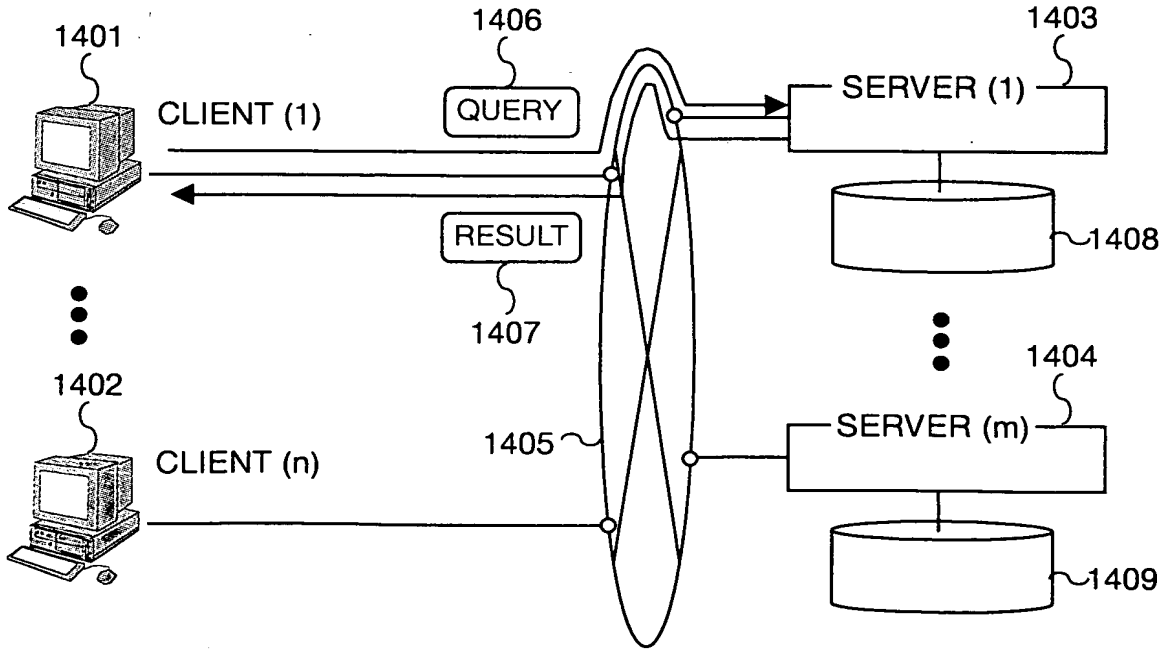

1401
CLIENT (1)
1406
QUERY
RESULT
1407
1402
CLIENT (n)
1405
1403
SERVER (1)
1408
1404
SERVER (m)
1409

Fig. 15

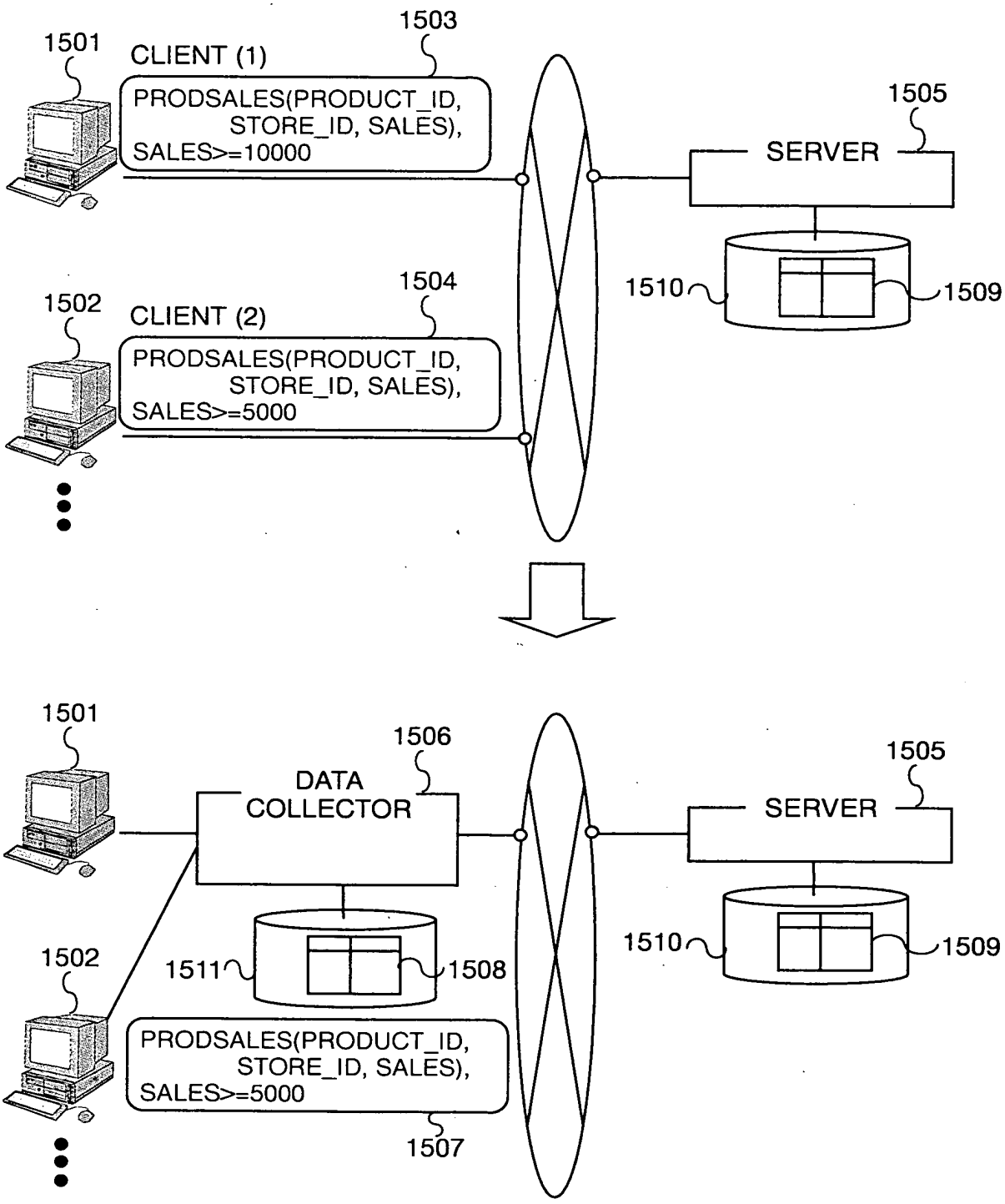

1501
CLIENT (1)
1503
PRODSALES(PRODUCT_ID, STORE_ID, SALES), SALES>=10000
1505
SERVER
1502
CLIENT (2)
1504
PRODSALES(PRODUCT_ID, STORE_ID, SALES), SALES>=5000
1510
1509
1501
1506
DATA COLLECTOR
1505
SERVER
1502
1511
1508
1510
1509
PRODSALES(PRODUCT_ID, STORE_ID, SALES), SALES>=5000
1507

Fig. 16

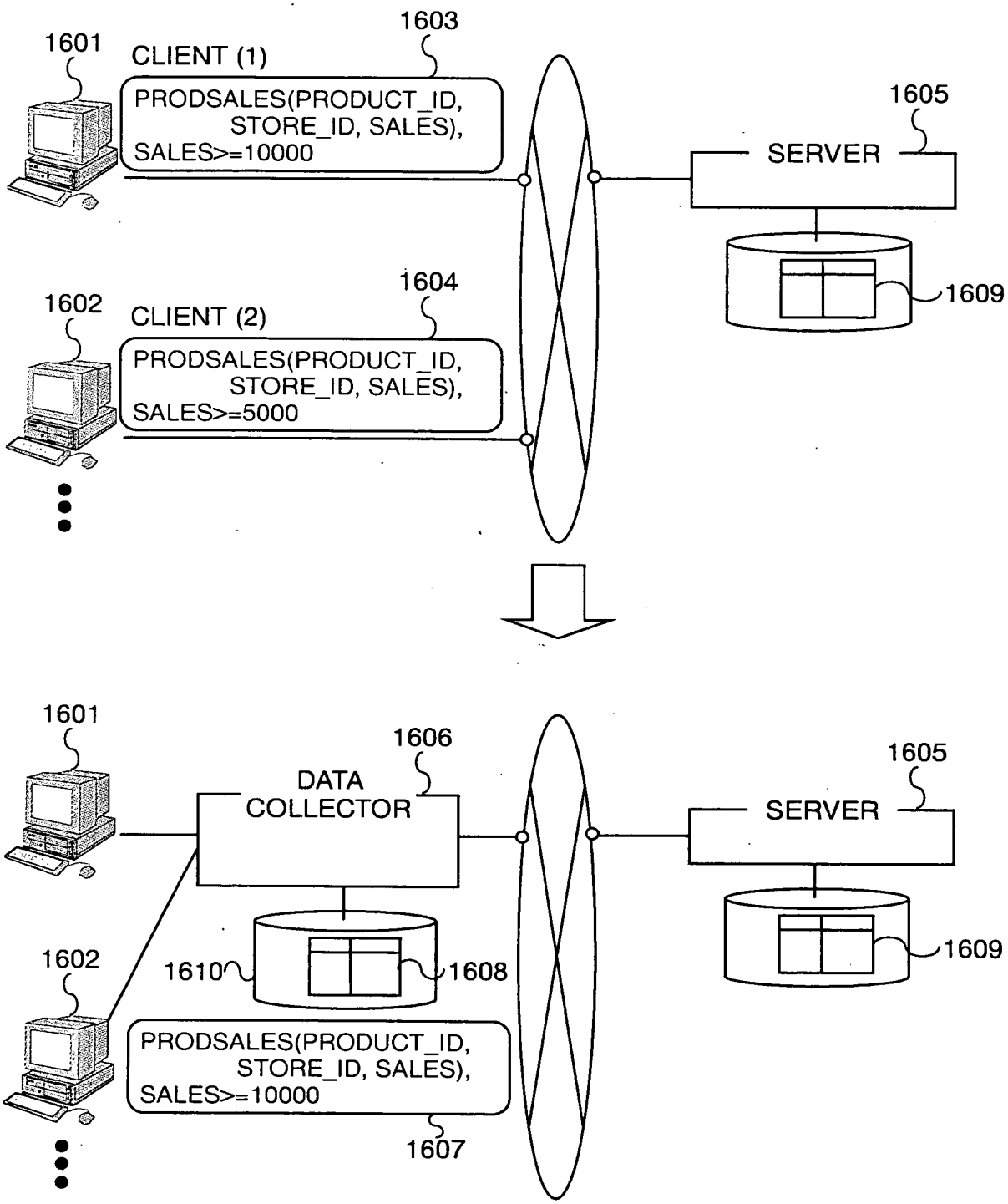
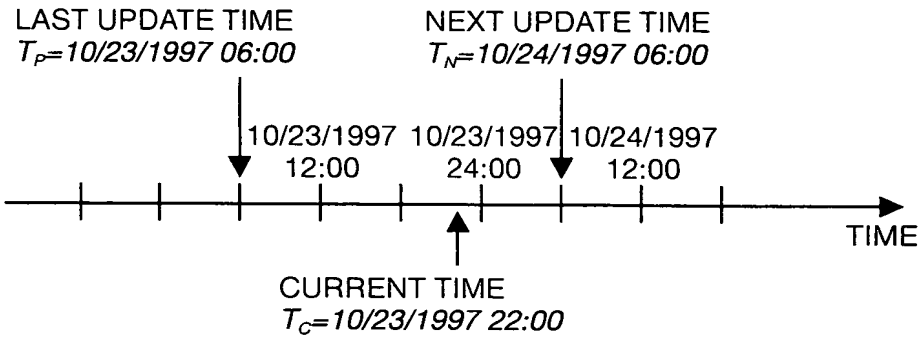

1601
CLIENT (1)
1603
PRODSALES(PRODUCT_ID, STORE_ID, SALES), SALES>=10000
1605
SERVER
1609
1602
CLIENT (2)
1604
PRODSALES(PRODUCT_ID, STORE_ID, SALES), SALES>=5000
1601
1606
DATA COLLECTOR
1605
SERVER
1609
1602
1610
1608
PRODSALES(PRODUCT_ID, STORE_ID, SALES), SALES>=10000
1607

Fig. 17

DATA UPDATE FREQUENCY REDUCTION USING DATA FRESHNESS CONDITION



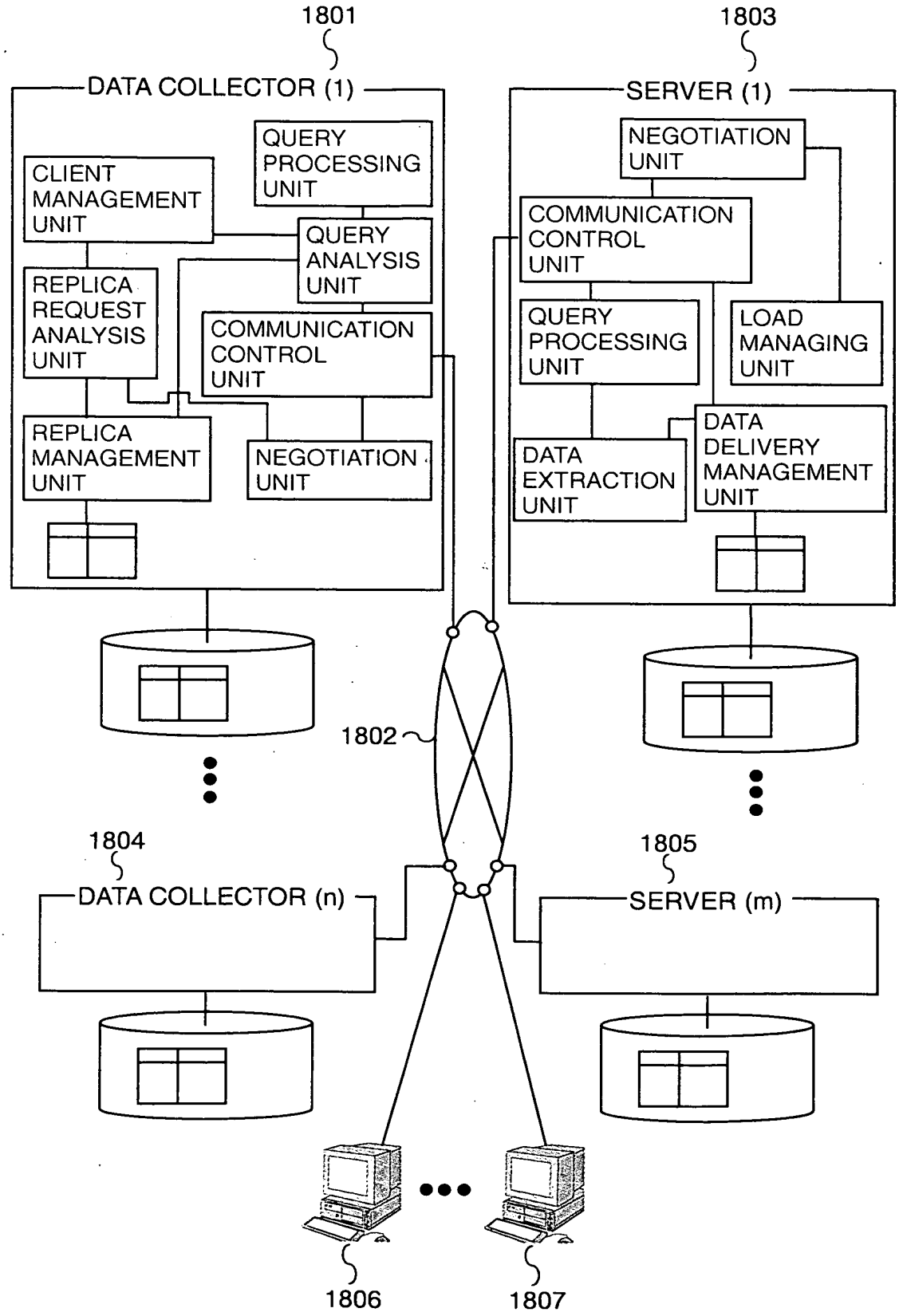
DATA FRESHNESS CONDITION: T_F = 1 day

$d_A(T_C) = d_A(T_P)$ $(T_C - T_P < T_F)$

Fig. 19

DATA RANGE	DATA QUALITY	DELIVERY METHOD	
ORDER(ORDER_ID, PRICE, CUSTOMER_ID) PRICE>=20000	-	ONCE BETWEEN 11:00 AND 15:00, PUSH	1901
ORDER(ORDER_ID, PRICE, CUSTOMER_ID), PRICE<=2000	-	ONCE PER 1 DAY, PUSH	1902
ORDER(ORDER_ID, PRICE, CUSTOMER_ID), PRICE<=2000	SAMPLE(ORDER, ORDER_ID, 10%)	ONCE BETWEEN 21:00 AND 23:00, PULL	
SALESDETAIL(ORDER_ID, SHIPDATE, ORDER_AMOUNT), SHIPDATE>=1990/01/01	TOP-N(SALESDETAIL, ORDER_AMOUNT, 100)	ONCE PER 1 HOUR, PULL	
...	...	...	

Fig. 18


1801
DATA COLLECTOR (1)
CLIENT MANAGEMENT UNIT
QUERY PROCESSING UNIT
QUERY ANALYSIS UNIT
REPLICA REQUEST ANALYSIS UNIT
COMMUNICATION CONTROL UNIT
REPLICA MANAGEMENT UNIT
NEGOTIATION UNIT
1803
SERVER (1)
NEGOTIATION UNIT
COMMUNICATION CONTROL UNIT
QUERY PROCESSING UNIT
LOAD MANAGING UNIT
DATA EXTRACTION UNIT
DATA DELIVERY MANAGEMENT UNIT
1802
1804
DATA COLLECTOR (n)
1805
SERVER (m)
1806
1807